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Wills et al.

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(54) EMERGENCY DEFLATE MECHANISM AND METHOD FOR INFLATABLE PACKER ASSEMBLIES

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(52) **U.S. Cl.** **166/387**; 166/187; 166/163; 277/333

(58) **Field of Search** 166/387, 187, 166/264, 191, 162–169; 277/333

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,629,446	A	*	2/1953	Freling et al.	277/333
3,327,781	A	*	6/1967	Nutter	166/264
4,082,298	A		4/1978	Sanford	
4,609,042	A	*	9/1986	Broadus et al.	166/187
4,676,096	A		6/1987	Bardsley et al.	73/155
4,676,310	A		6/1987	Scherbatskoy et al.	
4,712,613	A	*	12/1987	Nieuwstad	166/53
5,297,633	A		3/1994	Snider et al.	
5,353,637	A	*	10/1994	Plumb et al.	73/152.17
5,803,186	A	*	9/1998	Berger et al.	175/50
6,148,664	A	*	11/2000	Baird	73/152.38
6,192,982	B1		2/2001	Divis et al.	
6,257,338	B1		7/2001	Kilgore	

* cited by examiner

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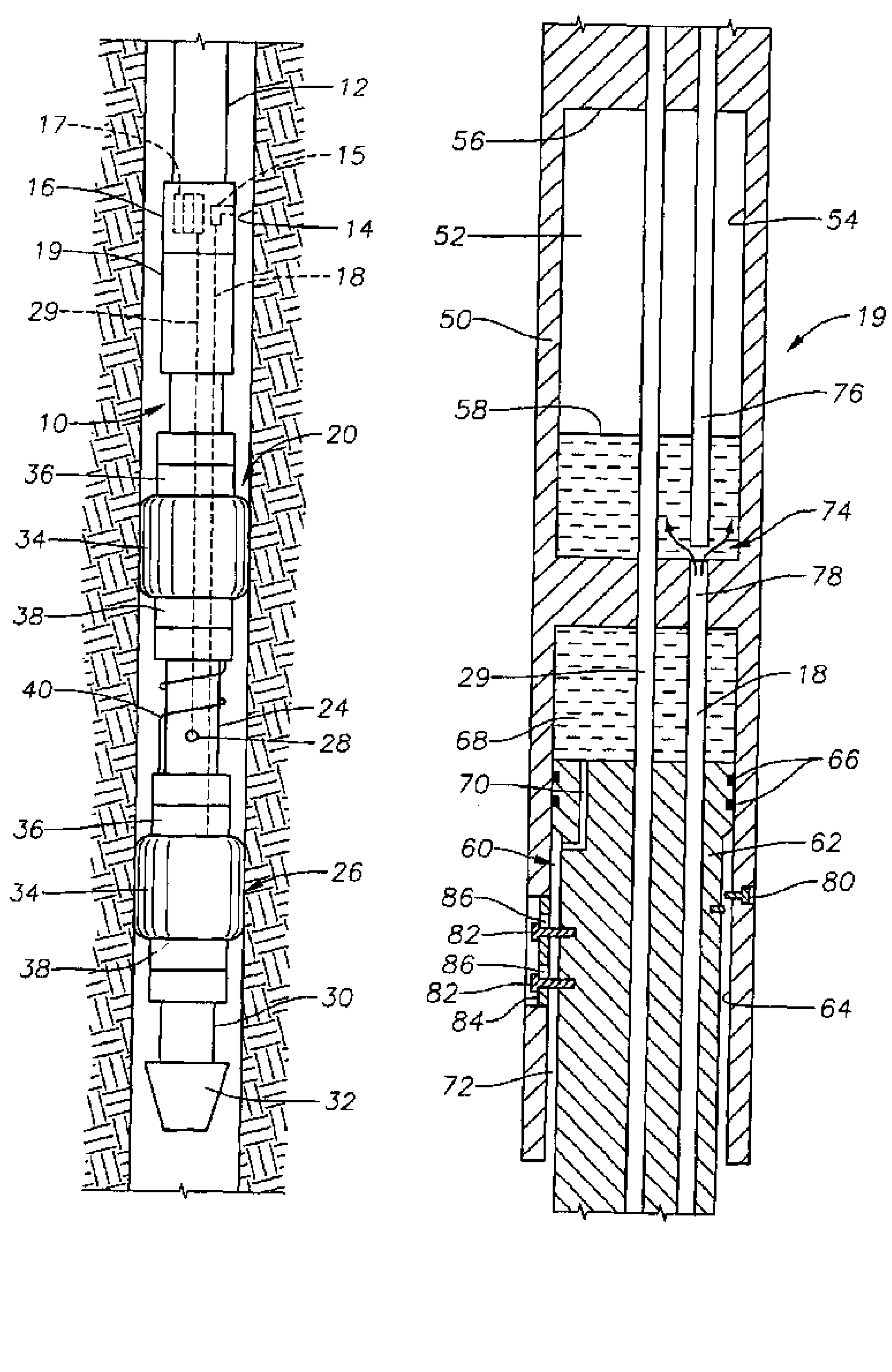
(57) **ABSTRACT**

Devices and methods are provided that permit a packer element to be deflated in the event of an emergency wherein power to the inflating pump is lost. An inflatable packer assembly having packer elements are selectively inflated by fluid pumped from the wellbore through an inflation tube into the packer elements. The packer assembly includes a deflation sub that houses the components of the emergency deflation mechanism. The deflation sub defines a dumping chamber that is at approximately atmospheric pressure, retains a portion of the inflation line for the packer elements and a means for separating the inflation line. To actuate the emergency deflation mechanism, an operator pulls up on the tubing string. A piston is then moved axially with respect to the housing, causing separation of the inflation line. Fluid from within the packer elements is then released into the dumping chamber to deflate the packer elements. Because the packer elements are subject to external hydrostatic pressure, the fluid contents will readily flow into the dumping chamber.

16 Claims, 3 Drawing Sheets



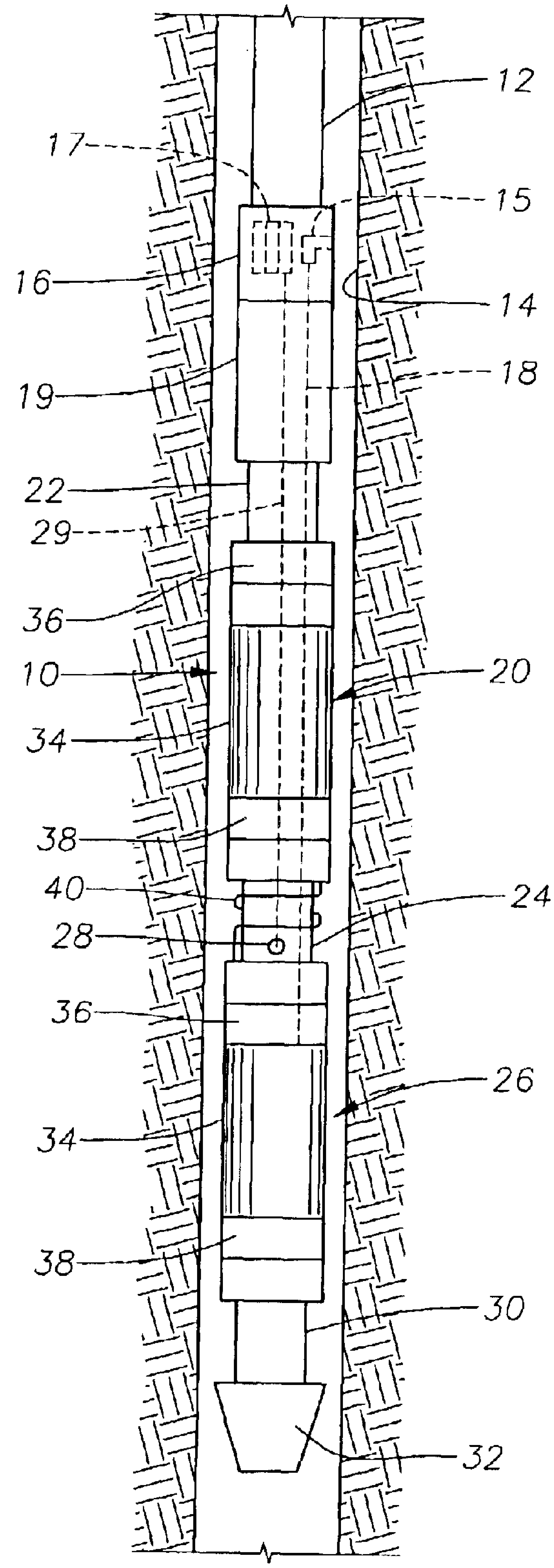

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Fig. 1

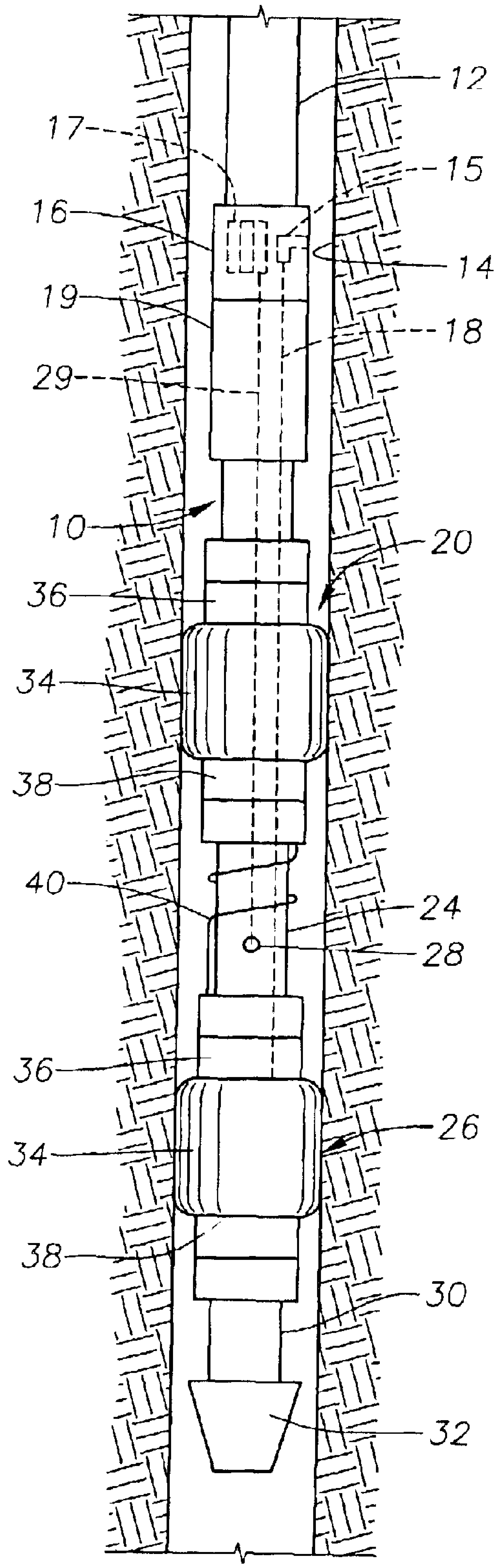
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Fig. 2

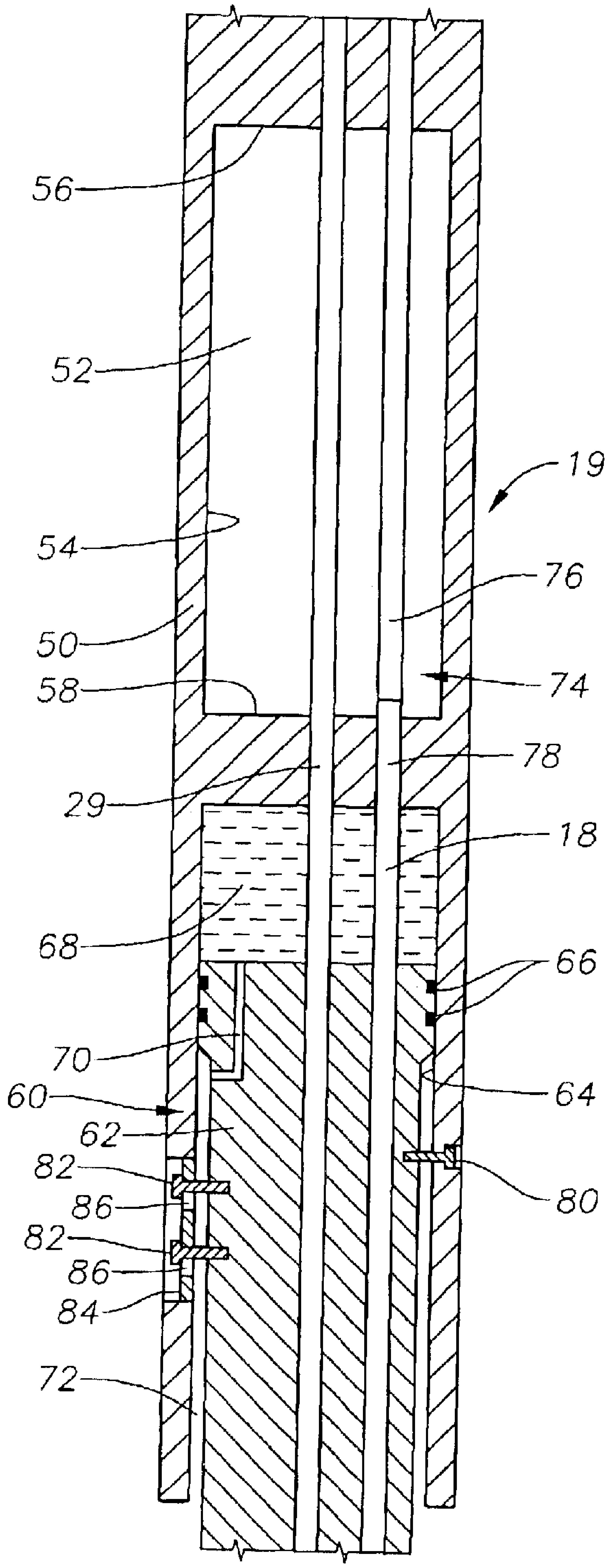
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Fig. 3

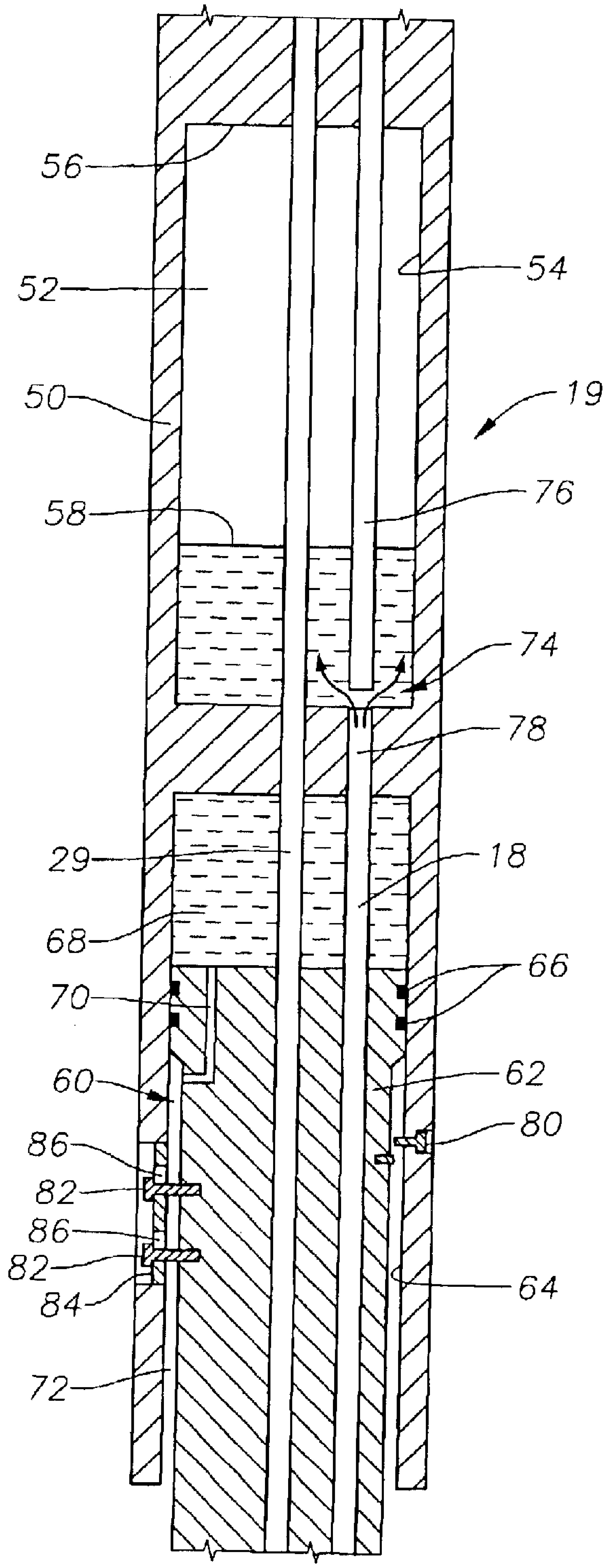
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Fig. 4

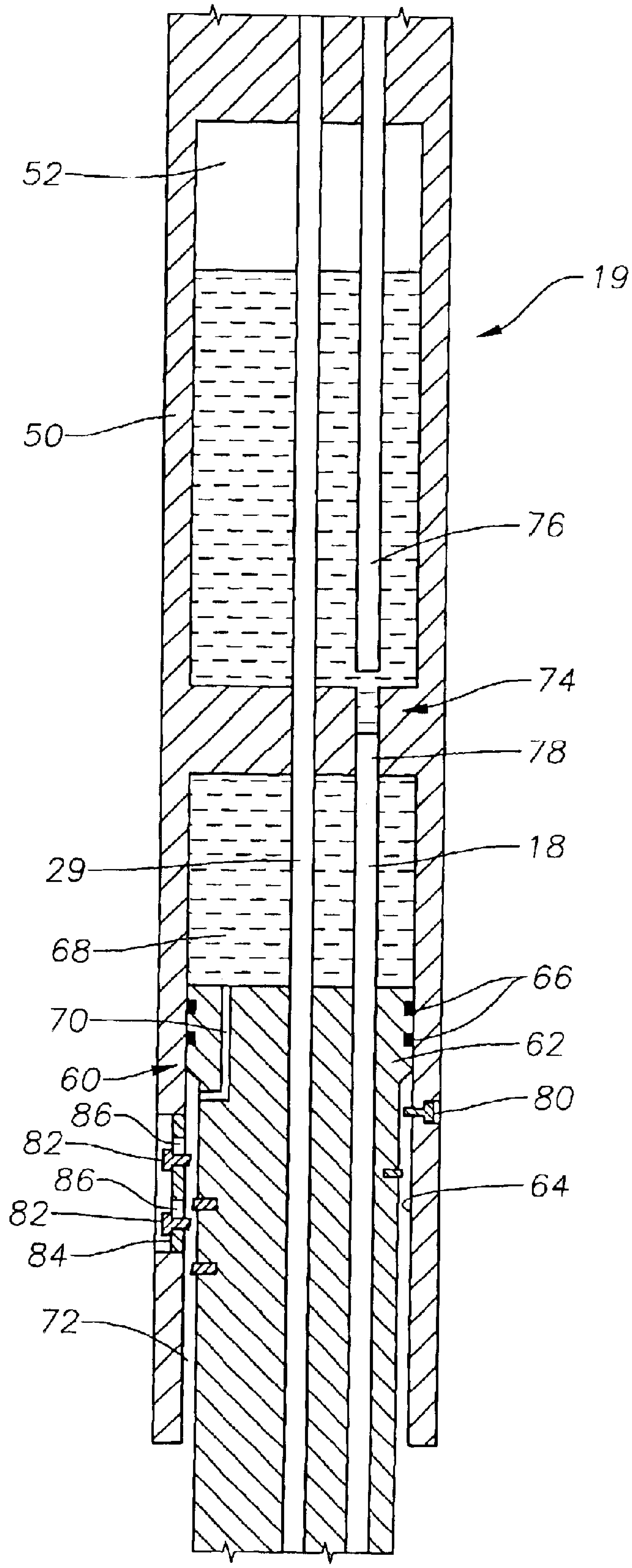

Fig. 5

EMERGENCY DEFLATE MECHANISM AND METHOD FOR INFLATABLE PACKER ASSEMBLIES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to devices and methods for deflation of an inflatable packer device in the event of a loss of power to the inflation pump or another emergency requiring a secondary method of deflation. In particular aspects, the invention also relates to inflatable packer assemblies that incorporate a deflate sub having a dumping chamber with an interior pressure that approximates atmospheric pressure.

2. Description of the Related Art

Inflatable packer assemblies are well known in the industry. These packer assemblies incorporate an inflatable packer element, or bladder, which is selectively inflated using a pump to flow fluid, such as borehole fluid, into the bladder. The packer element is ordinarily deflated by reversing the pump so that the fluid is flowed out of the bladder. A problem arises if there is an emergency wherein power is lost to the pump. The packer element cannot be deflated and, typically, the packer assembly must be detached from the tubing string. The tubing string is then removed from the borehole and the packer assembly subsequently removed using a fishing tool. This technique, while effective, is costly and time consuming. The well must be essentially shut down so that the tubing string can be removed and the fishing tool run in.

U.S. Pat. No. 5,297,633 issued to Snider et al. describes an inflatable packer assembly wherein a reciprocable fluid piston assembly is used to selectively inflate and deflate the packer. If the packer becomes stuck in the wellbore, the operator can pull up on the tubing string to shear a shear pin, thereby leaving the stuck packer in the well for later retrieval by a fishing tool. This solution for removing a stuck packer should be considered to be a last resort since it requires the well to be closed down, the sampling tool removed from the hole and a fishing device then run into the hole to retrieve the stuck packer. This is costly and time-consuming.

The prior art does teach the use of a bladder's natural shape memory to urge fluid out of the bladder. U.S. Pat. No. 4,676,310 issued to Scherbatskoy et al., for example, describes a transporter device for moving a logging tool. The transporter device includes an expandable bladder that is filled with fluid to become inflated and engage a borehole wall. The fluid is provided from an expandable reservoir. In one construction, the bladder is of a resilient construction that will normally urge fluid to flow back into the expandable reservoir. In practice, however, this arrangement is practically useless since the expandable reservoir is subject to hydrostatic pressure that precludes effective evacuation of the bladder. Little or no flow of fluid can be expected. Furthermore, there is no positive control of deflation.

An example of this is found in U.S. Pat. No. 6,257,338 issued to Kilgore, which describes a tubing string with multiple inflatable packers. The packers are inflated and deflated using a coupling that is conveyed down inside the tubing string on coiled tubing. When deflated, the fluid from the packer flows into the interior of the tubing string. Thus, fluid within the packer element is expected to flow into an area that is under hydrostatic pressure and, if such pressure is sufficiently great, deflation will be unsuccessful.

The arrangements of the prior art demonstrate the absence of an acceptable emergency deflation mechanism. To the

inventors' knowledge, there are no conventional arrangements that provide a suitable mechanism for deflation of the packer element in the event of a loss of power to the fluid inflation pump or another such emergency.

There is a need to provide improved methods and devices for rapid and effective deflation of an inflatable packer. The present invention addresses the problems of the prior art.

SUMMARY OF THE INVENTION

The invention provides devices and methods that permit a packer element to be deflated in the event of an emergency wherein power to the inflating pump is lost. The invention also provides a backup procedure in the event that deflation of a packer element using conventional techniques is not successful. The devices and methods of the present invention, therefore, provide a more certain technique for deflation and removal of a packer assembly short of having to detach the packer assembly from the tubing string and fishing it out of the borehole with a separate tool. Thus, the invention offers a significant savings of time and money over the prior art.

In a described embodiment, a well sampling tool is described that incorporates an inflatable packer assembly having packer elements are selectively inflated by fluid pumped from the wellbore through an inflation tube into the packer elements. The packer assembly includes a deflation sub that houses the components of the emergency deflation mechanism. The deflation sub defines a dumping chamber that is at approximately atmospheric pressure. The dumping chamber has a capacity that will accept enough of the fluid contents of the inflated packer elements so that the packer elements become deflated enough to become disengaged from the borehole wall. Additionally, the deflation sub retains a portion of the inflation line for the packer elements and a means for separating the inflation line. In a currently preferred embodiment, the means for separating the inflation line includes a split rod arrangement wherein two reversibly interconnectable portions of the line may be axially separated from one another. To enable separation of the split rod, a hydraulic piston arrangement is formed within the deflation sub having a piston and surrounding piston housing. Shear pins or other frangible members are used to prevent premature movement of the piston and to provide a positive indication of movement of the piston.

To actuate the emergency deflation mechanism, an operator pulls up on the tubing string. The piston is then moved axially with respect to the housing, causing the split rod arrangement to separate the inflation line. Fluid from within the packer elements is then released into the dumping chamber to deflate the packer elements. Because the packer elements are subject to external hydrostatic pressure, the fluid contents will readily flow into the dumping chamber. In the unlikely event that the emergency deflation mechanism fails, the packer assembly may still be separated from the tubing string, in the conventional manner and later retrieved with a fishing tool.

The invention also has applicability to other packer arrangements and mechanical tools that utilize hydraulic fluid to be selectively set within a wellbore.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side, cross-sectional view of a wellbore having a sampling tool therein that incorporates an inflatable packer assembly constructed in accordance with the present invention. In FIG. **1**, the packer elements are shown deflated, prior to inflation.

FIG. **2** is a side, cross-sectional view of the sampling tool shown in FIG. **1** with the packer elements now inflated to seal the wellbore.

FIG. **3** is an enlarged cross-sectional view of portions of the deflate sub portion of the inflatable packer assembly shown in FIG. **1** prior to an emergency deflation of the packer elements.

FIG. **4** is a view of the deflate sub portions shown in FIG. **3** after actuation of the emergency deflation mechanism.

FIG. **5** is a view of the deflate sub portions shown in FIGS. **3** and **4** following release of the packer assembly from the tubing string.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The term "emergency," as used herein, means an event wherein power to a fluid pump used to deflate a packer element is lost, or there is some other malfunction or incident wherein the packer cannot be deflated normally for removal from the wellbore. The term "emergency" also refers to any other event or contingency wherein the pump becomes unavailable or ineffective.

Referring first to FIG. **1**, an exemplary sampling tool, indicated generally at **10**, is shown secured to the lower end of a tubing string **12** within a wellbore **14**. The sampling tool **10** is used to obtain selective samples of fluid from certain depths within the wellbore **14**. The sampling tool **10** consists of several individual subs, shown in schematic fashion, that are interconnected.

The uppermost portion of the sampling tool **10** is an extraction sub **16** that is secured to the lower end of the tubing string **12**. The extraction sub **16** houses sample tanks **17**, of a type known in the art, that retain wellbore or formation fluids that are captured by the sampling tool **10**. Additionally, the extraction sub **16** houses a submersible pump **15** that draws fluid from within the wellbore **14** and pumps it through an inflation line **18** to the packer elements **34** of the tool **10**.

Located beneath the extraction sub **16** is an emergency deflation sub **19**, the structure and function of which will be described in detail shortly. The deflation sub **19** is secured to an upper packer assembly **20** by a short mandrel **22**. A sampling mandrel **24** interconnects the upper packer assembly **20** to a lower packer assembly **26**. The sampling mandrel **24** includes at least fluid port **28** through which borehole fluid may be drawn in. A sampling line **29** extends from the fluid port **28** to the sampling tanks **17** within the extraction sub **16** so that fluid may be drawn into the tanks **17**.

A lower mandrel **30** interconnects the lower packer assembly **26** with a bullplug **32**. The upper and lower packer assemblies **20**, **26** each have an inflatable packer element, or bladder, **34**. The inflatable packer elements **34** are of a type known in the art, typically formed of an elastomeric material and inflated by filling with fluid. The inflation line **18** provides a fluid pathway between the packer elements **34** and the wellbore **14**. When so inflated, the packer elements **34** expand radially to engage and seal against the wall of the wellbore **14**. Each of the packer assemblies **20**, **26** includes collars **36**, **38** that are disposed upon and affixed to each end of the packer element **34**. The upper collars **36** are fixed against axial movement, while the lower collars **38** are axially moveable when required to compensate for inflation of the packer elements **34**. In FIG. **1**, the tool **10** is shown in an unset position, such as during run-in, wherein the packer elements **34** are in an uninflated condition and the tool **10** may be moved upwardly and downwardly within the wellbore **14**.

FIG. **2** shows the tool **10** set within the wellbore **14**, the packer elements **34** having been inflated so as to seal against the wall of the borehole **14**. The elements **34** are inflated by pumping fluid from the borehole **14** through the inflation line **18** and into each of the packer elements **34**. It is noted that a portion **40** of the inflation line **18** is coiled about the circumference of the sampling mandrel **24**. When the upper packer element **34** is inflated, as shown in FIG. **2**, the lower collar **38** moves axially upwardly, thereby increasing the distance between it and the upper collar **36** of the lower packer assembly **26**. The coiled portion **40** compensates for this increase in distance, as can be appreciated by reference to FIGS. **1** and **2**.

Referring now to FIGS. **3**, **4** and **5**, the interior of the deflation sub **19** is shown in cross-section. The deflation sub **19** includes a tubular housing **50** that defines a dumping chamber **52** therewithin. The dumping chamber **52** is empty of liquid initially and of a sufficient volume to accommodate enough of the fluid contents of the two packer elements **34** to ensure deflation of the packer elements **34** so that the elements **34** become disengaged from the wall of the borehole **14**. Further, the dumping chamber **52** is maintained at a pressure that is significantly lower than the hydrostatic pressure within the wellbore **14**. In a currently preferred embodiment, the dumping chamber **52** is at approximately atmospheric pressure. No special preparation of the dumping chamber **52** is required. The chamber **52** will contain normal atmospheric gases and should be sealed prior to running into the borehole **14**. The dumping chamber **52** is bounded by the outer radial wall **54** of the housing **50** and at each axial end by a bulkhead or wall **56**, **58**.

Beneath the dumping chamber **52** is a hydraulic piston assembly, generally indicated at **60**, that includes a piston **62** reciprocally retained within a piston cylinder, or piston housing **64**. O-ring seals **66** surround the piston **62** and create a fluid seal against the piston housing **64**. A hydraulic chamber **68** is formed at the upper end of the piston **62**. The hydraulic chamber **68** is filled with hydraulic fluid. A hydraulic metering port **70** is disposed through the piston **62** to permit fluid communication between the hydraulic chamber **68** and the annulus **72** defined between the piston **62** and the piston housing **64** on the opposite side of the seals **66**. When the piston **62** is moved with respect to the piston housing **64**, hydraulic fluid is metered through the port **70** between the annulus **72** and the chamber **68**.

The inflation line **18** and the sampling line **29** are disposed axially through the housing **50** of the deflation sub **19** so that each passes through the piston **62**, the hydraulic chamber **68** and the dumping chamber **52**. The inflation line **18** includes a separable split rod portion **74** wherein a upper portion **76** and a lower portion **78** are reversibly affixed together. The lower portion **78** leads to the packer elements **34** and is secured within the piston **62** so as to move with the piston **62**. The upper portion **76** is fixedly disposed within the housing **50**.

A first shear screw **80**, or set of shear screws, is disposed though the outer housing **50** and the piston **62**. The shear screw **80** secures the piston **62** axially with respect to the housing **50** and is a frangible member that will break upon application of a preset amount of axial force to the housing **50**. A second set of shear screws **82** is also disposed through the housing **50** and into the piston **62**. This set of shear screws **82** are each placed through a plate **84** in the housing **50** having enlarged openings **86**. The openings **86** permit some movement of the shear screws **82** therewithin. The second set of shear screws **82** requires a greater force to shear than the first shear screw **80**.

In operation, the sampling tool **10** is lowered to a desired depth within the wellbore **14** and is then set within the wellbore **14** by inflation of the packer assemblies **20**, **26**. The pump **15** is actuated to flow wellbore fluid into the packer elements **34**. The set position for the tool **10** is illustrated in FIG. **2**. Once the tool **10** is set, formation fluids are then drawn into the sample tanks **17** through port **28** and sampling line **29**. When it is desired to unset the tool **10**, either to remove it from the wellbore **14** or to move it to another location, the pump **15** is actuated to reverse the flow of fluid, drawing it from the packer elements **34** and returning it to the wellbore **14**. This is the conventional method of unsetting the tool **10**. In an emergency, the packer elements **34** are deflated by pulling up on the tubing string **12** and, thus, the housing **50** of the deflation sub **19**. A predetermined amount of upward force is applied to the tubing string **12** that is sufficient to shear the first shear screw **80** but not the second set of shear screws **82**. The first shear screw **80** separates, thus permitting the housing **50** to move with respect to the piston **62**. Fluid is metered through the metering port **70** into the hydraulic chamber **68** to compensate for the displacement of the piston **62**. The second set of shear screws **82** are moved within the openings **86** but are not broken. As this movement of the piston **62** occurs, the split rod arrangement **74** separates the upper and lower portions **76**, **78** of the inflation line **18** proximate the dumping chamber **52**. This position is shown in FIG. **4**. With the upper and lower portions **76**, **78** now separated, fluid within the packer elements **34** exits the lower portion **78** into the dumping chamber **52**. The fluid is urged into the chamber by the pressure differential between the hydrostatic pressure within the wellbore **14** (acting upon the outside of the packer elements **34**) and the lower pressure within the dumping chamber **52**. The packer elements **34** are thereby deflated at least sufficiently to permit them to be disengaged from the borehole wall.

In the unlikely event that the packer elements **34** are not successfully deflated using the above-described method, the tool **10** may then be separated from the tubing string **12** to permit later removal by a fishing tool. To separate the tool **10** from the tubing string **12**, a second upward force is applied to the tubing string **12**. The second upward force is greater than the first upward force previously applied to shear screw **80**. The second upward force is sufficient to shear the second set of screws **82** as shown in FIG. **5**. The second upward force separates the housing **50** from the piston **62**. The sampling line **29** will be broken away as well as the deflation sub **19** is separated from the packer assemblies **20**, **26**.

It will be understood by those of skill in the art that the devices and methods of the present invention are not useful only with inflatable packer devices but are also applicable to other tools and devices that are set using hydraulic fluid, such as a mechanical packer device that uses hydraulic setting. Those of skill in the art will recognize that numerous modifications and changes may be made to the exemplary designs and embodiments described herein and that the invention is limited only by the claims that follow and any equivalents thereof.

What is claimed is:

1. An inflatable packer assembly for use in a borehole comprising:

a packer element that is selectively inflatable by filling with fluid and deflatable by expelling of fluid;

a fluid pathway for transmitting fluid to the packer element from a fluid source; and

a fluid dumping chamber operably associated with the packer element to receive fluid therefrom during deflation of the packer element, the fluid dumping chamber having an internal pressure that is below hydrostatic pressure within the borehole.

2. The inflatable packer assembly of claim **1** wherein the internal pressure approximates atmospheric pressure.

3. The inflatable packer assembly of claim **1** wherein the fluid pathway comprises an inflation line having a split rod assembly that permits the inflation fine to be readily separated into two portions so that fluid may enter the dumping chamber.

4. The inflatable packer assembly of claim **3** further comprising a hydraulic piston assembly for separating the inflation line, the hydraulic piston assembly comprising:

a tubular outer piston housing; and

a piston reciprocally retained within the piston housing.

5. The inflatable packer assembly of claim **4** wherein the piston is releasably secured to the piston housing by a first frangible member that breaks upon application of a first predetermined force to the hydraulic piston assembly.

6. The inflatable packer assembly of claim **5** wherein the piston is further releasably secured to the piston housing by a second frangible member that breaks upon application of a second predetermined force to the hydraulic piston assembly, the second predetermined force being greater than the first predetermined force.

7. The inflatable packer assembly of claim **1** wherein the fluid dumping chamber is defined within a deflation sub that is selectively releasable from the packer element.

8. A device for deflating an inflatable packer element within a wellbore comprising:

a housing defining a fluid dumping chamber therein for receiving fluid from within the inflatable packer element, the dumping chamber having an internal pressure that is below wellbore hydrostatic pressure;

a fluid pathway between the inflatable packer element to be deflated and the fluid dumping chamber; and

a release mechanism for selectively releasing fluid from the inflatable packer element into said dumping chamber.

9. The device of claim **8** wherein the release mechanism comprises a split rod assembly incorporated into the fluid pathway.

10. The device of claim **9** wherein the release mechanism further comprises a hydraulic piston assembly.

11. The device of claim **8** wherein the internal pressure of the dumping chamber approximates atmospheric pressure.

12. The device of claim **8** wherein the housing comprises a separate deflation sub that is releasably secured to the inflatable packer element.

13. A method for deflating an inflatable packer element that is filled with fluid, the method comprising the steps of:

providing a fluid pathway from the packer element to a fluid dumping chamber having an internal pressure that is below wellbore hydrostatic pressure; and

allowing packer element shape memory and hydrostatic wellbore pressure to expel fluid from the packer element into the dumping chamber.

14. The method of claim **13** wherein the internal pressure of the dumping chamber is approximately atmospheric pressure.

15. The method of claim **13** wherein the step of providing a fluid pathway to the dumping chamber comprises severing a fluid inflation line.

16. The method of claim **15** wherein the fluid inflation line is severed by actuating a hydraulic piston assembly.

* * * * *